Thin Mirror Shaping Technology for High-Throughput X-ray Telescopes

Completed Technology Project (2014 - 2016)

Project Introduction

This proposal is submitted to the NASA Research Opportunities in Space and Earth Sciences program (ROSES-2012) in response to NASA Research Announcement NNH12ZDA001N-APRA. It is targeted to the Astronomy and Astrophysics Research and Analysis (APRA) program element under the Supporting Technology category. Powerful x-ray telescope mirrors are critical components of a raft of small-to-large mission concepts under consideration by NASA. The science questions addressed by these missions have certainly never been more compelling and the need to fulfill NASA's core missions of exploring the universe and strengthening our nation's technology base has never been greater. Unfortunately, budgetary constraints are driving NASA to consider the cost/benefit and risk factors of new missions more carefully than ever. New technology for producing x-ray telescopes with increased resolution and collecting area, while holding down cost, are key to meeting these goals and sustaining a thriving high-energy astrophysics enterprise in the US. We propose to develop advanced technology which will lead to thin-shell x-ray telescope mirrors rivaling the Chandra x-ray telescope in spatial resolution but with 10-100X larger area–all at significantly reduced weight, risk and cost. The proposed effort builds on previous research at MIT and complements NASA-supported research at other institutions. We are currently pursuing two thin-mirror technology development tracks which we propose to extend and accelerate with NASA support. The first research track utilizes rapidly-maturing thermal glass slumping technology which uses porous ceramic air-bearing mandrels to shape glass mirrors without touching, thus avoiding surface-induced mid-range spatial frequency ripples. A second research track seeks to remove any remaining mid- to long-range errors in mirrors by using scanning ion-beam implant to impart small, highly deterministic and very stable amounts of stress into thin glass, utilizing local bending moments to correct mirror shape. Preliminary results from our lab demonstrate the simplicity, specificity, and exquisite sensitivity of this technique on silicon and glass wafers. We believe that the combination of these new technologies has the potential to revolutionize thin mirror shaping technology and will enable a renaissance in high-energy astrophysics.

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Organizational Responsibility

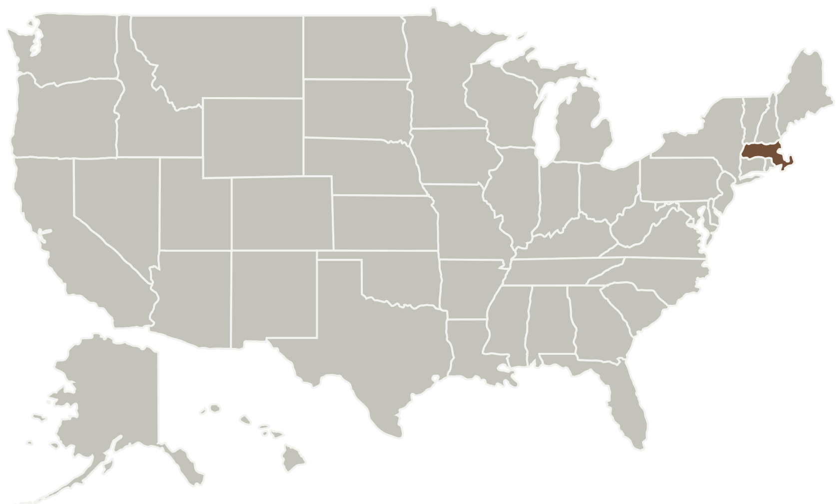
Responsible Mission Directorate:

Science Mission Directorate (SMD)

Responsible Program:

Astrophysics Research and Analysis

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
Massachusetts Institute of Technology(MIT)	Supporting Organization	Academia	Cambridge, Massachusetts

Primary U.S. Work Locations
Massachusetts

Project Management

Program Director:
Michael A Garcia

Program Manager:
Dominic J Benford

Principal Investigator:
Mark Schattenburg

Co-Investigators:
Ralf Helimann
Martin Klingensmith

Technology Areas

Primary:

- TX08 Sensors and Instruments
  └─ TX08.2 Observatories
    └─ TX08.2.1 Mirror Systems

Target Destination

Outside the Solar System